

Permit Conditions
for
Electron Microscopy Facilities

Background

Authority to possess and operate an electron microscope (EM) is granted to an individual by the Radiation Safety Committee after the user’s application has been reviewed and approved by the US Department of Agriculture (USDA) Radiation Safety Staff (RSS).

In addition to the x-ray producing aspects of the EM, naturally occurring radioactive materials are often used to prepare samples for analysis.

Facilities have discovered radioactive materials contamination during renovation of electron microscopy laboratories.

The permit holder shall comply with all safety and regulatory requirements of the USDA Radiation Safety Program.

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Approved: 10/9/96 Date	By: /s/ John T. Jensen Director, Radiation Safety Staff
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General Requirements

Acquisition

Purchase orders for EM’s need to be approved by the RSS prior to the order being placed by a purchasing agent.

Upon receipt of any EM, the following information must be submitted to the RSS:

- X-ray Producing Equipment Inventory Record (RSS-29);
- A copy of the manufacturer’s information and specifications, such as a sales brochure.

Radiation Safety Considerations

X-ray Production

Modern EMs are constructed to limit the x-rays typically produced during routine operating conditions. Shielding is designed into most systems to avoid the production of x-rays at the junctions of column sections and viewing and sample ports.

A limit of 0.5 mR/hr, measured at 5 cm from the surface, is the measurement level universally adopted as a survey standard. This limit is the USDA policy for this category of x-ray emitting devices.

Radioactive Materials

It is common for electron microscopy facilities to use naturally occurring radioactive materials in their laboratories. This includes:

- Uranyl Acetate;
- Uranyl Sulfate;
- Uranyl Nitrate; and
- Thorium Nitrate.

These compounds are not regulated by the Nuclear Regulatory Commission, and can be purchased without a specific license from most major chemical companies. Stock containers of these isotopes typically have radiation levels of 5 mR/hr at the surface, and their use can be a source of contamination if good laboratory procedures are not followed. The USDA regulates the possession of these compounds by policy.

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X-ray Safety

Specific Requirements	<p>The USDA program for controlling x-ray hazards from EMs has been adopted from the Electron Microscopy Safety Handbook, published by the San Francisco Press, 1985. These requirements are as follows:</p> <ul style="list-style-type: none">• All EMs are to meet the radiation level requirements of the Radiation Control for Health and Safety Act of 1968;• Oversight of EMs is to be accomplished by a properly trained individual, named on a Radiation Source Permit issued by the RSS and• The manufacturer must submit information to the permit holder regarding the potential for x-ray leakage and must provide advice regarding minimizing the risk of generating leaks during operation of the EM.
Radiation Surveys	<p>Surveys for leakage radiation are to be performed upon installation, upon significant modification or repair of the equipment, or when conditions indicate a potential problem.</p>
Posting of Signs and Labels	<p>External x-ray radiation is not typically produced under normal operating conditions; no signs or labels are required to be posted at the entrance to rooms containing EMs.</p>
Personnel Dosimetry	<p>Review of dosimetry records by RSS demonstrate there is no occupational exposure to operators of EMs. Therefore, no personnel monitoring is required.</p> <p>If radiation monitoring is desired, the use of long-term environmental area monitors is recommended. These are available from the RSS.</p>
Transfer	<p>The RSS must be notified of the transfer of an EM to another USDA permit holder or to an individual outside the USDA.</p>
Disposal	<p>The proper disposal of unused EMs is required.</p> <p>In older units, cooling oil in the high voltage supply or in the x-ray tube may contain polychlorinated bi-phenyls (PCBs). This hazard must be investigated and controlled at the time of disposal.</p>

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Radioactive Materials Safety

Inventory Control	<p>As part of the permitting process, the permit holder must indicate whether or not naturally occurring radioactive materials will be used in the laboratory. These materials must be listed on an Application for Radioactive Materials Use, Continuation Sheet (Form RSS-21a). These isotopes and compounds will be listed on the Radiation Source Permit.</p> <p>The total amount of natural uranium and thorium possessed by the USDA must be maintained below certain regulatory limits. The amount of each compound possessed by the permit holder must be reported to the RSS on an annual basis.</p>								
Contamination Control	<p>The primary concern regarding the use of radioactive materials is the control of radioactive contamination.</p> <p>After each use of radioactive compounds involving the preparation of stock solutions containing uranium or thorium, the work area should be cleaned.</p> <p>Sinks used for the disposal of liquid solutions should be rinsed thoroughly to avoid the accumulation of radioactive materials in the trap or other sections of the drain pipe.</p>								
Contamination Surveys	<p>Surveys for contamination should be performed after each use of radioactive compounds involving the preparation of stock solutions.</p> <p>A thin end window Geiger-Müller (G-M) detector, connected to a count rate meter is typically used for these surveys. The counting efficiency for natural uranium and thorium should be known (this value is 25 percent for most instruments). The instrument must be calibrated on an annual basis.</p>								
Contamination Limits	<p>The limits for uranium and thorium contamination are shown in the following table:</p> <table><tr><td>Fixed Contamination</td><td>Average Maximum</td><td>5,000 DPM / 100 cm² 15,000 DPM / 100 cm²</td></tr><tr><td>Removable Contamination</td><td>Maximum</td><td>1,000 DPM / 100 cm²</td></tr></table>			Fixed Contamination	Average Maximum	5,000 DPM / 100 cm ² 15,000 DPM / 100 cm ²	Removable Contamination	Maximum	1,000 DPM / 100 cm ²
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Removable Contamination	Maximum	1,000 DPM / 100 cm ²							

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Radioactive Materials Safety, Continued

Disposal of Nitrate Compounds	Uranyl nitrate and thorium nitrate are considered a mixed waste by the Environmental Protection Agency (EPA) and require special handling. If it is permitted by state regulation, the compounds may be mixed with plaster or some other solidification process used to eliminate the oxidizing component of the chemical. Once solidified, the compounds must be handled as low-level radioactive waste.
Disposal of Laboratory Samples	<p>The preferred method for discarding small volumes of stock solutions is to pour it into a sink that is connected to a sanitary sewer system. This assumes that sewer disposal is approved for your location. The Location Radiation Protection Officer (LRPO) at the facility can provide assistance in this activity and should be contacted prior to any disposal.</p> <p>Based on the amounts of radioactive materials typically used in an electron microscopy facility, no estimates of the concentrations of these materials disposed through the sewer system are required. For those facilities actively monitoring all disposals of radioactive materials, the specific activity and sewer disposal limits for these compounds are listed in Table 1.</p> <p>Following any disposal, the sink must be rinsed with copious amounts of water.</p> <p>If sewer disposal is not permitted, the materials must be disposed of as radioactive waste.</p>
Disposal of Stock Chemicals	<p>Stock bottles containing unused uranium or thorium compounds should be disposed as radioactive waste or should be transferred to another electron microscopy facility willing to accept the materials.</p> <p>Large quantities of these compounds must not be dissolved and disposed through the sanitary sewer system.</p>
Close-out Survey	<p>Electron microscopy laboratories using radioactive materials must perform a close-out survey when the laboratory is closing and the EMs are being disposed -or when the use of radioisotopes is being discontinued. The close-out survey documents that radioactive contamination is not present, and the laboratory may be released for unrestricted use.</p> <p>The RSS has developed a Technical Bulletin titled “Performing Close-out Surveys in Radioisotope Laboratories” that provides detailed guidance for this process.</p>

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Radioactive Materials Safety, Continued

Table 1: Uranium and Thorium Compounds, Specific Activities, and Sewer Disposal Limits

Compound	Chemical Formula and Formula Weight	Specific Activity $\mu\text{Ci/gm}$	Sewer Effluent Limit $\mu\text{Ci/ml}$
Uranium (0.45%)	u 235	5×10^{-1}	3×10^{-6}
(NAT)		7.06×10^{-1}	
Uranyl Acetate (0.45%)	$\text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$ 422	3.2×10^{-1}	
(NAT)		4.5×10^{-1}	
Uranyl Sulfate (0.45%)	$\text{U}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ 366	3.2×10^{-1}	
(NAT)		4.5×10^{-1}	
Uranyl Nitrate (0.45%)	$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ 502	2.8×10^{-1}	
(NAT)		3.9×10^{-1}	
Thorium (NAT)	Th 232	2.2×10^{-1}	3×10^{-7}
Thorium Nitrate (NAT)	$\text{Th}(\text{NO}_3)_4 \cdot 12\text{H}_2\text{O}$ 696	0.7×10^{-1}	

General Information

Records The following table lists the period of time that radiation safety program records must be retained.

Record Type	Retention Period (Years)	
	Permit Holder	RSS
Purchase or Transfer of Electron Microscopes	3	Indefinite
Purchase or Transfer of Radioisotopes	3	Indefinite
Disposal of Radioisotopes	Indefinite	Indefinite
Radioactive Waste Manifests	Indefinite	Indefinite
Contamination Survey Results	3	3

Questions If there are any questions regarding the information in this document, contact:

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